THE MESHLESS FINITE ELEMENT METHOD USED AS A PARTICLE METHOD TO SOLVE INCOMPRESSIBLE FLUID MECHANIC PROBLEMS

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The idea of meshless methods for numerical analysis of partial differential equations has become quite popular over the last decade. It is widely acknowledged that 3-D mesh generation remains one of the most man-hours consuming techniques within computational mechanics. The development of a technique that does not require the generation of a mesh for complicated three-dimensional domains is still very appealing. The problem of mesh generation is in fact an automatization issue. The generation time remains largely time consuming, even using the most sophisticated mesh-generator. Therefore, for a given distribution of points, it is possible to obtain a mesh very quickly, but it may also require several iterations, including manual interaction, to achieve an acceptable mesh. On the other hand, meshless methods need node connectivity to define the interpolations. The accuracy of a meshless method depends, to a great extent, on the node connectivity. Unfortunately, the correct choice of the node connectivity may also be an iterative problem; in that case, the use of a meshless method may be superfluous. Many of the meshless method proposed in the literature need more time in the definition of the node connectivity than a standard mesh generation.

Meshless Methods have been developed both for structural and fluid mechanics problems. All these methods use the idea of a polynomial interpolant that fits a number of points minimizing the distance between the interpolated function and the value of the unknown point. These ideas were proposed first by Nayroles *et al.*, they were later used in structural mechanics by Belytschko *et al.* and in fluid mechanics problems by Oñate *et al.*. Lately, the meshless ideas were generalized to take into account the finite element type approximations in order to obtain the same computing time in mesh generation as in the evaluation of the meshless connectivities . This method was called the Meshless Finite Element Method (MFEM) [1] and uses the Extended Delaunay Tessellation to build the mesh in a computing time which is linear with the number of nodal points.

In contrast with other methods found in the literature, the MFEM [2] has the advantages of a good meshless method concerning the ease of introduction of nodes connectivity in a bounded time of order $\approx$ n, and the condition that the shape functions depends only on the node positions. Furthermore, the method proposed also shares several of the advantages of the Finite Element Method such as: (a) the simplicity of the shape functions in a large part of the domain; (b) Co continuity between elements, which allows the treatment of material discontinuities, (c) an easy introduction of the boundary conditions, and (d) symmetric matrices.

References
[1] S.R. Idelsohn, E. Oñate, N. Calvo and F. Del Pin, *The meshless finite element method*, In press in Int. J. for Numerical Methods in Engineering, (2002).
[2] S.R. Idelsohn, E. Oñate and F. Del Pin, *A lagrangian meshless finite element method applied to fluid-strucrure interaction problems*, In press in Computer & Structures, (2002).